Pure Tone Audiometry

Pure-tone audiometry is a behavioural test used to measure hearing sensitivity. This measure involves the peripheral and central auditory systems.

Pure-tone thresholds (PTTs) indicate the softest sound audible to an individual at least 50% of the time.

Hearing sensitivity is plotted on an audiogram, which is a graph displaying intensity as a function of frequency.

Degrees of hearing loss

- Ψ Normal hearing (0-25 dB): At this level, hearing is within normal limits.
- Ψ Mild hearing loss (26-40 dB): Mild hearing loss may cause inattention, difficulty suppressing background noise, and increased listening efforts.
    - o Patients with this degree of loss may not hear soft speech and conversations especially in noisy and reverberant situations.
    - o Children may be fatigued after listening for long periods.
- Ψ Moderate hearing loss (41-55 dB): Moderate hearing loss may affect language development, syntax and articulation, interaction with peers, and self-esteem.
    - o Patients with this degree of loss have trouble hearing some conversational speech.
    - o Higher volumes are needed for TV and Radio
- Ψ Moderate-severe hearing loss (56-70 dB): Moderate-severe hearing loss may cause difficulty with speech and decreased speech intelligibility.
    - o Patients with this degree of loss do not hear most conversational-level speech as clarity of speech is considerably affected.
- Ψ Severe hearing loss (71-90 dB): Severe hearing loss may affect voice quality.
    - o Regular speech is inaudible.
    - o Comprehension is possible through shouting or amplification.
- Ψ Profound hearing loss (>90 dB): With profound hearing loss (deafness), speech and language deteriorate.
    - o Even amplified speech is difficult to understand or even audible.

Terminology

Audiogram

- Ψ The audiogram is a chart of hearing sensitivity with frequency charted on the abscissa and intensity on the ordinate.
- Ψ Intensity is the level of sound power measured in decibels;
- Ψ Loudness is the perceptual correlate of intensity.
- Ψ For threshold testing intensity, decibels are measured in hearing level (HL), which is based on the standardized average of individuals with normal hearing sensitivity.
- Ψ HL is not equivalent to sound pressure level (SPL)
- Ψ Frequency is cycles per unit of time. Pitch is the perceptual correlate of frequency. Frequency is measured in hertz, which are cycles per second.
- Ψ Usually frequencies of 250-8000 Hz are used in testing because this range represents most of the speech spectrum, although the human ear can detect frequencies from 20-20,000 Hz. Some children can detect even higher frequencies.

Pure-tone average

- Ψ Pure-tone average (PTA) is the average of hearing sensitivity at 500, 1000, and 2000. This average should approximate the speech reception threshold (SRT), within 5 dB, and the speech detection threshold (SDT), within 6-8 dB.
- Ψ If the SRT is significantly better than the PTA, the possibility of *pseudohypoacusis* should be considered.
- Ψ If the PTA is significantly better than the SRT, the possibility of central involvement should be considered.

Speech reception threshold

- Ψ The SRT is the softest intensity spondee words that an individual can repeat at least 50% of the time.
- Ψ Spondees are bisyllabic words equally emphasizing both syllables. In some cases (eg, patients with poor word recognition), a limited set of words may be used.

Speech detection threshold

- Ψ The speech detection threshold (SDT), also termed the speech awareness threshold (SAT), is the lowest intensity speech stimulus that an individual can detect at least 50% of the time. Word recognition

- Ψ Word recognition (formerly called speech discrimination) is the ability to repeat correctly an open set of monosyllabic words at suprathreshold intensity. Word lists are phonetically balanced (PB), meaning that the speech sounds used occur with the same frequency as in the whole language.

- Ψ The score represents the percent of words correct for most word recognition tests.

Technique: Some important Points

Crossover

- Ψ Crossover occurs when sound presented to the test ear travels across the head to the non-test ear. This occurs at approximately 40 dB for circumaural earphones across all frequencies. When hearing sensitivity is much poorer in the test ear than the non-test ear, the signal may cross over and be perceived in the ear with better hearing, thus yielding a false impression of the intended test ear's sensitivity.

- Ψ Insert earphones reduce the crossover by reducing surface contact area.

Masking

- Ψ Masking presents a constant noise to the non-test ear to prevent crossover from the test ear. The purpose of masking is to prevent the non-test ear from detecting the signal (line busy), so only the test ear can respond.

- Ψ When a signal is presented to the test ear, the signal may also travel through the head and reach the cochlea on the other side. However the intensity of the signal from the test to the non-test ear can be reduced by the mass of the head. This signal reduction is called interaural attenuation.

- Ψ For bone conduction, the interaural attenuation may be as low as 0 dB because the bones of the skull are very efficient at transmitting sound.

- Ψ Thus, any suspected difference in bone conduction between the test and non-test ears requires masking.

- Ψ Inter-aural attenuation for air conduction can range between 40 and 80 dB.

Ψ Masking should be used if the difference in air conduction in one ear and bone conduction in the other ear is 40 dB or greater.

Ψ Thresholds obtained with masking in the contralateral ear are called masked thresholds and should represent the true threshold of the test ear.

Ψ A masking dilemma occurs when masking from the non-test ear crosses over to the test ear and affects threshold testing for the test ear. In this case, a reliable masked threshold cannot be obtained and is referred to as the masking dilemma. This phenomenon generally occurs only in the presence of a substantial conductive component to the hearing loss and is less problematic with the more common use of insert earphones.